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Some Experiments made in the Air-pump *by Monſieur* Papin, *directed by Monſieur* Hugens, (*as appears in the Diſcourſe printed at* Paris, 1674.)

TO mingle divers Liquors together by means of the *Air-pump*, there were employed two ſmall Glaſſes, whereof the one could enter into the other, and the leaſt of the two was faſtned to the hook of an Iron-wire, and the greater put under it, and the ſaid Wire was ſo ordered, that theſe two Glaſſes were a little diſtant one from another, until the Recipient [†] were eva-

[†] The *Recipient*, which was employ'd in this Engin, was of a Cylindrical figure, of which *one* end is all open, to be faſtned to the cement of this Pump; the *other* is all cloſed, except a ſmall hole, having a little edge or brim; through which hole you paſs the hook'd Iron-wire, mentioned in the diſcourſe, and tye an Eel-skin cloſe about the ſame and three or four inches higher. The ſame skin is alſo to be tyed about the Iron-wire, to keep the external Air from entring into the Recipient, and yet without taking away the liberty to ſtir therein what you will by means of the Iron-wire, that hath a Communication inwards and outwards. For this purpoſe you muſt chuſe that part of the Eel-skin that is next to the head, the other part being pierced with many holes with valves that do not always ſhut well.

To be the more ſure, that no Air enters by the ligatures of the Eel-skin, you may apply a Tube on the Recipient with cement, and pour water into this Tube until the Eel-skin be quite cover'd therewith. Care alſo muſt be had, that the whole be exactly fill'd up by the Iron-wire; for, if it were too big, the Eel-skin would be thruſt into it with great violence, and ſo hinder the liberty of raiſing and ſinking it.

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cuated of Air. Whereupon, by means of the Iron-wire, the leſſer Glaſs was let down into the greater, until the Liquors, they contain, did mingle themſelves. Thus ſome *Aqua fortis* was poured into the upper Glaſs, and *Spirit of Wine* into the lower, and the Recipient was ſo well exhauſted of the Air, that the *Spirit of Wine* boyled up with great bubbles (as uſually it doth,) and the *Aqua fortis* caſt ſome ſmall bubbles. After that both theſe Liquors were well purged of Air, the upper Glaſs was ſunk into the lower, ſo as that the Spirit of Wine was mingled with the *Aqua fortis*; at which inſtant there was yet ſeen a very conſiderable Ebullition.

Now to know, whether the *Aqua fortis* gave to the *Spirit of Wine* ſome new vigor or ſorce to make it bubble; we mixed *without* the Recipient ſome *Aqua fortis* with Spirit of wine; the quantity of the former being ſomewhat more than that of the later. This mixture being put in *vacuo*, inſtead of boyling up more ſtrongly than the Spirit of Wine, (as 'twas thought it would have done,) it only caſt up ſome few bubles: Which ſhew'd, that the Ebullition, which was ſeen when they were mixed *within* the *vacuum*, is of the ſame nature with all thoſe that are made of Acids and Alcalies. For, in the very inſtant that they are mixed they make great ebullitions, but ſoon after they mortifie one another, and looſe the proprieties they had before. 'Tis alſo probable, that the *Aqua fortis* and the Spirit of Wine would boyl always, when they are ming'ed, but that the preſſure of the Air keeps this ebullition from being ſenſible, and appears only when that preſſure is taken off.

When you employ rectified Spirit of Wine inſtead of *Aqua vitæ*, there is required a greater quantity of *Aqua fortis* to mortify it.

It was alſo experimented, that the ſolution of *Common Salt* boyls alſo with *Spirit of wine*, being mixed *in vacuo*, and the ſolution of *Salt-peter* yet more. The ſame Experiment was alſo made with common water, and it's ebullition with *Aqua vitæ*, purged of Air, was alſo found to be very great, when mixed *in vacuo*.

Further, it is ſomewhat remarkable, that *common Water* doth not mortify Spirit of Wine, as *Aqua fortis* doth, though they make ebullition with it almoſt of the ſame degree. The Experiment of it is eaſy: For, making *without* the Recipient, a mixture of *common Water* and *Aqua vitæ*, this, being put *within* the *vacuum*, bubles up very well, though the *common Water* be there in greater quantity than the *Aqua vitæ*; whereas a mixture of *Aqua fortis* and *Aqua vitæ* did not there buble up at all.

After this, the Experimenter being deſirons to ſee, whether theſe Ebullitions did make new Air; he put in the Recipient a *Gage* (that is a *glaſs tube* fill'd either with Water freed of air, or with Mercury, ſerving to meaſure the quantity of the Air in the Recipient) which was four Inches long, and obſerv'd, that at the inſtant when the Liquors were mingled together, the water in the Gage roſe very nimbly to the top of the gage; and then drawing out this new Air that was made, he made the gage-water ſubſide again by degrees, in like manner as when the common Air is drawn out: And by this means, it was ſeen, that all theſe kinds of ebulition make an Air which expands it ſelf like common Air *.

Yet here is ſomething that ſeems to be very remarkable: which is, that the Air which is made by theſe ebullitions, is not of the ſame nature. For, it hath been found experimentally, that the Air formed by the mixture of *Aqua fortis* and *Copper* remains alwaies Air, and alwaies keeps up the water in the Glaſs at that height to which it raiſed it; but on the contrary, that Air which hath been produced by the mixture of *Oyl of Tartar* and *Oyl of Vitriol*, is al-

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* On this occaſion, I am obliged to take notice, that (as 'tis recorded in the Journal-Book of the *R. Society*, A. 1668. *April* 30.) the honourable Mr. *Boyle* gave an account to the ſaid *Society* of the Experiments, he had then made about generating new Air, or extricating that Air which was lurking before in ſeveral bodies: At which time he mention'd alſo ſome ways of examining, whether the ſubſtance thus produced be *true* Air or not.

And long before that time, *viz.* *A* 1664 the 15*th.* of *March*, (witneſs the ſame *Journal*) Mr. *Boyle* mention'd to the *R. Society*, that Corals or Oyſter-ſhels pounded, and put into diſtilled Vinegar, might prove fit Subſtances to produce Air wholeſom for Inſpiration. At which time he alſo propos'd, that ſome fit *animal* might be put into a Receiver of his Exhauſting Engin, and the Air pumped out till the creature grew ſiekiſh, and that then ſome new Air might be produced in the Receiver by a contrivance of making diſtill'd Vineger work upon the ſubſtances before-mention'd; to ſee, whether by this means the Animal would recover.

About which time Sir *Chr. Wren* alſo ſuggeſted, to put a fermenting liquor in a glaſs-ball, and to fit a ſtop-cock to it, and ty a bladder about the top of the ſtop-cock, by which means the Air, to be generated by the fermenting liquor, would paſs into the bladder, and upon the turning of the ſtop-cock be kept there in the form of Air. Mr. *Hook* alſo mention'd ſeveral liquors, which by their working upon one another would produce an Air; as *Oyl of Tartar* and *Vitriol*; *Spirit of Wine* and *Turpentine*. And the ſame made before the *R. Soc.* the following Expeeiment: He took a common glaſs-viol with two Pipes, and ſome pounded Oiſter-ſhels and *Aqua fortis*; and as ſoon as the latter was by one of thoſe pipes powred upon the former, and the hole ſtop't with good cement, the Ebullition, cauſed by the ſhels being corroded by the *Aqua fortis*, did in a very little time blow up the bladder, tyed on to the other pipe, ſo as to ſwell it very plump with Air; which expanſion remained till the *Society* roſe, after they had order'd the ſaid veſſel to be carefully lock't up till their next meeting, which being the week after, the bladder was then found ſomewhat ſhrunk. The like Experiment was made with *bottled Ale*, ſuppoſed to yield a more wholſome Air for reſpiration, &c.

moſt all deſtroyed of it ſelf in the ſpace of twenty four hours, inſomuch that in the Recipient, twenty four hours *after* that the ebullition had been there made, there was not found much more Air than there was *before* the ſame was made.

One day we mingled equal parts of *Aqua fortis* and *Aqua vitæ*, and having put two equal quantities of this mixture in two ſmall Glaſſes with two equal bits of *Iron*, one into each; one of theſe Glaſſes was included *in vacuo*. Then there was ſeen a very great Ebullition, and the liquor became black, whilſt that was left *without* the Recipient wrought almoſt nothing, but remained alwaies tranſparent, and rather white than black. After theſe two Glaſſes had thus ſtood twelve hours, that which was in *vacuo* was taken out, and found, that the Iron was almoſt all diſſolved, whereas the other was very little diminiſhed. This Experiment ſucceeds quite contrary when 'tis made with *Aqua fortis* alone and *Copper*; for then the diſſolution is leſs *within* the *vacuum*, than *without* it.

We made ſome other mixtures of divers liquors, which make no ebullition at all in *vacuo*, no more than they do in the open Air. *Oyl of Olives* makes none neither with *Vinegar*, nor with *Spirit of Wine* at *the inſtant* that they are mingled; neither doth the ſaid Oyl mortifie the *Spirit of Wine*. Only this we obſerved one day, that having mingled together, *without* the Recipient, ſome of that *Oyl* and *Vinegar* and *Spirit of Wine*, and put this mixtnre in *vacuo*; it did not boyl up ſo ſoon as when there was no *Oyl*; but then the bubbles which it made afterwards were bigger, and they began to appear again from time to time, ſo that ſome of them were ſeen a quarter of an hour after the Recipient had been evacuated. Poſſibly this may come to paſs, becauſe that the Oyl, ſwimming on the top, retains the more volatil parts of the *Spirit of Wine*, which elſe would flie away as ſoon as the Air is begun to be pump'd out, and at the ſame time it hinders the ſurface of the liquor below from eaſily riſing up into bubbles, becauſe, to make them do ſo, the parts of the Oyl that ſtick cloſe to one another, muſt be ſeparated. When therefore the volatil parts are gather'd together in a ſufficient quantity, able to ſurmount the reſiſtance which the Oyl makes to it, they iſſue out with much more violence, than if nothing had retained them.

All theſe Ebullitions, hitherto ſpoken of, are greater in *vacuo* than in the open Air: But with *Lime* it is not ſo. For, taking two equal Glaſſes with two equal quantities of Water, and putting the one of them in *vacuo*; the other in the free Air, there was let fall into both at the ſame time two equal parcels of *Lime*, one into each; and it appear'd, that that which was in *vacuo* did indeed throw up ſome big bubbles, but yet fewer of them than that which was in the Air: And having taken it, an hour after, out of the Recipient, and ſtirr'd the *Lime*, it was found to have only the conſiſtence of Dirt, whereas the other had the conſiſtence of ſlecked Lime. The reaſon of which may perhaps be, that the Volatil Salts of the *Lime* do exhale whilſt the Recipient is emptying.

There was alſo ſome Plaiſter of *Paris* ſlecked in *vacuo*, and the Ebullition of it did there appear much more than it doth in the open Air. When it is not touched, the bubbles that iſſue out leave great holes in it, and then it ſettles very un-even; but taking care to ſtir it until the bubbles be come forth, and preſſing it when it begins to ſettle, it becomes very ſmooth, and hath not ſo many little holes as the common Plaiſter.

A particular account, given by an anonymous French *Author in his book of the* Origin of Fountains, *printed* 1674 *at* Paris; *to ſhew, that the Rain and Snow-waters are ſufficient to make Fountains and Rivers run perpetually.*

IN order to give a groſs Eſtimat of the quantity of Rain *, compared with the quantity of Water running away in Springs and Rivers; it will be neceſſary firſt to agree of the way of meaſuring theſe two ſorts of Water. Thoſe that make profeſſion of governing and conveying Spring-waters, ſay, that a cubick inch of water yields in twenty four hours 144 *muids*, (the name of a *French* meaſure, holding 280 *French* pints;) others ſay, it yields but 70 of that meaſure. For my part, I have reaſon to believe, that it yields 83 of this meaſure, and follow thoſe that ſay, that a Veſſel of two foot deep, long and broad, holds one *muid* of Water.

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* The like to which hath been attempted here, and propoſed to the *R. Society*, ſome years ſince, by Sr. *Chr. Wren*, who by the contrivance of a Rain-bucket had taken an account of all the Water that fell for a conſiderable time; and by his Weather-clock had, among other particulars, not only taken in the meaſuring of the quantity of Rain that falls, but alſo the time when it falls, and how much at each time. Which Inſtrument, if put into practice, would be of excellent Uſe, foraſmuch as it may alſo ſerve, by ſome additions made thereunto by *M. Hook*, to record the weight of the Air, the drought, moiſture, heat and cold of the Weather, the Sun-ſhine, the quarters and ſtrength of the Winds: And all this to be performed by one only motion, driving all the parts of the Inſtrument; which is therefore the more conſiderable, that it ſelf records its own effects.